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Doing Science in a Time of Austerity

James C. Bigelow*

Department of Biomedical and Pharmaceutical Science, Idaho State University, Pocatello, Idaho, USA

Doing science has never been an easy task and finding funding and resources for investigator-initiated research has long been a full-time job in and of itself. As the causes and effects of the Great Recession linger on, perhaps indefinitely, this job will become even more difficult and the way we do science may have to change permanently, perhaps for the better.

Science, as is generally understood, is mostly a product of Renaissance and post-Renaissance Europe. As such, basic research, as with much of art and literature, was a luxury; an activity society could expend surplus resources on when the tasks of daily living were accounted for. Funding for it generally depended on the resources of independently wealthy investigators or royal patronage. In the latter case, then, as now, immediate military or commercial application was often the goal. The explosion of investigator-initiated basic science is largely the product of post-World War II conditions.

In the aftermath of World War II, the critical role of science and technology was self-evident and pure research was recognized as a necessity. Vannevar Bush, in his cover letter for the 1945 report *Science, The Endless Frontier*, best summarizes this: "Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress."

Science has more than fulfilled its promise, delivering a seemingly endless stream of advances. However, the success of science must be seen in its historical context. In the years following the launch by the USSR of *Sputnik 1*, research funding was relatively easy to obtain. The sub-text of this funding was always that no matter how "pure" the research was, the research would eventually provide military and economic advantages to the the United States and its allies in the Cold War and again science delivered. The Cold War is now history but long before it was over, obtaining research funding and support for its foundation, higher education, was not easy in any context. Despite the great success of science, why is this so? To see why, we must look beyond the political imperatives of the post-World War II world that supported science and examine its true foundation. That foundation was continuous economic growth.

Growth, generally defined by economists as increasing GDP, has been essentially constant throughout the planet, particularly since the end of WW II. It has been locally reversed and delayed by recessions, wars and various political upheavals but has not altered its upward trend. In the aftermath of the Great Recession, politicians have promised to restore growth and implement policies to insure a continuous expansion in GDP. With growth, jobs and prosperity will follow as will research funding. But is continuous grow desirable or even possible? One may debate the former, but continuous growth, be it in a population or in economic activity is not possible on a finite planet. At some point, a limitation in one or more resources or the accumulation of waste products will cause growth to cease. If the process of growth is halted or controlled by negative feedback as is seen in a stable ecosystem, then sustainable long-term economic conditions can be established.

To individuals and politicians, when economic growth ceases, then austerity seemingly must follow, and there are many indications that economic growth as it has been known and understood is beginning to cease. Important indicators include the availability and price of petroleum. Global oil production has been stagnate since 2005 despite steadily rising prices until it is now approaching the 2008 spike of almost $150 per barrel. Many new areas of oil exploration and extraction are difficult, either physically such as the Artic or deep waters, or found in politically unstable regions. Conflicts over over access to fresh water can be expected to intensify in coming decades. Loss of biodiversity will accelerate and with it, significant economic loss, either directly such as in the collapse of commercially valuable wild fish populations or in the inability of the environment to remediate pollution and provide "services" such as pollination, groundwater renewal or carbon sequestration.

While there is much room for debate, one must consider the very real possibility that the era of continuous economic growth is now ending and the Great Recession may be a harbinger of that end. If this is the case, we, as scientist must take stock of our role in shaping the world we will leave to our children and grandchildren and well as how we will work in and shape a more austere future for scientific research.

Scientists have long taken the lead in warning of environmental dangers and will continue to do so. If our species can find its way through the environmental problems that wait in the decades ahead, it will be scientist and engineers who will provide the solutions and leave our progeny a better world. Beyond that, how we do science in a non-growth economy will be different from how we do it now. Without growth as we understand it, resources will be much more limited. With limited resources, the paradigm of "publish or perish" should be discarded as being unsustainable. Science should be much less about building an academic fiefdom, though that will probably always remain, but more about doing science just to do science. Science will have to be done at a much slower pace, to accommodate the fewer resources available to support and thus become much more contemplative. It may also become more integrated into early education and much less the province of PIs, post-docs and graduate students. However, by the testimony of its success, it will never again be regarded as a luxury. In these things we may see a better future.

***Corresponding author:** James C. Bigelow, Associate Professor, Department of Biomedical and Pharmaceutical Science, Idaho State University, Pocatello, Idaho, USA, E-Mail: jbigelow@otc.isu.edu

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